IN THE MATTER OF

U.S. Provisional Application **60/458,412**

By Samsung Electronics Co., Ltd

I, Eun-mee Won, an employee of Y.P.LEE, MOCK & PARTNERS of The Cheonghwa Bldg., 1571-18 Seocho-dong, Seocho-gu, Seoul, Republic of Korea, hereby declare that I am familiar with the Korean and English language and that I am the translator of U.S. Provisional Application and certify that the following is to the best of my knowledge and belief a true and correct translation.

Signed this 7th day of January 2004

Eunmee Won

Abstract of the Disclosure

A method and apparatus for guaranteeing seamless reproduction of data strings are provided. The method includes creating continuous time control information that is used to control an instant of time when the data strings are output for the seamless reproduction of the plurality of data strings that include packetized data to which arrival time stamps are allocated. Accordingly, it is possible to continuously reproduce data strings having different arrival time clocks (ATCs) without pause.

METHOD OF GUARANTEEING SEAMLESS REPRODUCTION OF A PLURALITY OF DATA STRINGS AND REPRODUCING APPARATUS FOR PERFORMING THE SAME

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to seamless reproduction of a plurality of continuous data strings, and more particularly, to a method of guaranteeing seamless reproduction of a plurality of continuous data strings and an apparatus for performing the same.

2. Description of the Related Art

In an information storage medium on which packet data is recorded, arrival time stamps (ATSs) are allocated to the recorded data, and the ATSs are important because the data is reproduced based on the ATSs. Conventionally, each data string is given an ATS that is independent from those allocated to other data strings, since continuous reproduction is required only within a data string.

For this reason, there are no particular regulations for continuous reproduction of the two data strings, and thus, a pause between reproductions of the two data strings is unavoidable when a user reproduces two continuous data strings in serial.

FIG. 1 illustrates a basic format of packet data recorded with ATSs, and the relationship between the arrival time of the packet data and the output time of the packet data that is reproduced. Referring to FIG. 1, input data is recorded with ATSs and reproduced based on the ATSs. Here, the input data is packetized data indicating video and/or audio data that is divided into predetermined units and may be transmitted through a satellite, cable, or a local area network (LAN). The predetermined unit is 188 bytes long when using a moving picture expert group (MPEG)-2 transmission stream under the ISO/IEC 13818-1 standard, and is 53 bytes long when using the asynchronous transfer mode (ATM) standard.

In digital broadcasting, a plurality of packet data are transmitted at irregular intervals of time. The transmitted packet data passes through a buffer, which includes a decoder, at a receiving side and is decoded by the decoder so that a user can view the digital broadcasting. A reproducing apparatus temporarily stores the packet data, reads back the packet data, and outputs it to the decoder, so as to

reproduce the packet data at a desired instance of time a user desires. The irregular intervals of time at which the packet data was transmitted are significant when the packet data is output to the decoder. If the irregular intervals of time are not abided by, continuous reproduction of multiple data is not ensured due to overflow or underflow of the buffer at the receiving side. Therefore, a transmitting side is required to transmit the packet data while adjusting intervals of transmission time of the packet data appropriately, in consideration of the state of the buffer at the receiving side.

Accordingly, the ATS of packet data transmitted in packet units to a recording apparatus is added to all packets and recorded, and is again output to a reproducing apparatus during reproduction of the packet data.

FIG. 2 is a block diagram illustrating the structure of an apparatus that records and reproduces the packet data shown in FIG. 1. Referring to FIG. 2, a counter that operates in response to a system clock signal basically uses a 27 MHz clock signal since an MPEG-2 system generates all time stamps in response to the 27 MHz clock signal. Alternatively, system clock signals in different frequencies can be used. An ATS generator allocates an individual ATS to every received packet data. The ATS-allocated data is converted into a recordable signal using a recording controller and recorded on a recording medium.

A reproduction controller reads the ATS-allocated data from the recording medium and provides the read data as data to be reproduced to an ATS processor. Then, the ATS processor outputs the data by referring to the ATS allocated to the data. Here, each of the ATS generator and the ATS processor includes a built-in buffer. Alternatively, a buffer may be installed outside each of the ATS generator and the ATS processor.

A method of allocating an ATS to packet data will now be described in detail. First, when packet data is input to the ATS generator, the ATS generator reads a count value of the counter at the time when the packet data is input and allocates the read count value as a value of the ATS to the incoming packet data. The ATS-allocated packet data is temporarily stored in the built-in buffer included in the ATS generator and recorded on the recording medium using a recording controller. As mentioned above, the buffer may be installed outside the ATS generator. During a read operation, the reproduction controller reads the ATS-allocated packet data from the recording medium and provides it to the ATS processor. Since the built-in

buffer is of predetermined size, the ATS processor repeats stopping reading of data when overflow of the buffer is caused and restarting reading of data when the buffer is empty.

Also, the ATS processor reads the packet data that is first transmitted to the built-in buffer, and the ATS from the packet data, and outputs the packet data while setting the counter with the value of the ATS. The data output from the ATS processor is original packet data from which the ATS is removed. In connection with next packet data, the ATS processor compares the ATS values allocated to the next packet data with the count value and outputs only packet data whose ATS value is equivalent to the count value. As mentioned above, the ATS processor includes a built-in buffer but a buffer may be installed outside the ATS processor. In this way, packet data can be transmitted to the receiving side having the decoder at the same intervals of time as when the packet data was transmitted, thereby enabling seamless decoding of the packet data.

As shown in FIGs. 1 and 2, packet data is recorded to include an ATS indicating the arrival time of incoming packet data. A data stream recorded in this way is called a stream object (SOB). In general, a plurality of SOBs are recorded on a recording medium. For instance, one SOB is created during which recording starts and ends, and another SOB is created during which recording starts and ends. Here, the SOB refers to data recorded during which recording starts and ends. For instance, a drama or a movie may be recorded in a data stream format.

FIG. 3 illustrates a process of reproducing two stream objects (SOBs) using the apparatus of FIG. 2. Referring to FIG. 3, ATSs are recorded starting from 100 to 990 in a previous SOB *SOB1*, whereas ATSs are recorded starting from 0 in a next SOB *SOB2*. That is, the ATS generator of FIG. 2 records the previous SOB *SOB1* while allocating ATSs to respective incoming packet data of the previous SOB *SOB1*, starting from of an ATS value 100 to first incoming packet data; and records the next SOB *SOB2* while allocating ATSs to respective incoming packet data of the next SOB *SOB2*, starting from allocation of an ATS value 0 to first incoming packet data, regardless of the ATS of the previous SOB *SOB1*. To continuously reproduce the two SOBs *SOB1* and *SOB2*, the previous SOB *SOB1* is reproduced while comparing the values of the ATSs allocated to the previous SOB *SOB1* with a count value. Next, after the reproduction of the previous SOB *SOB1*, the count value is reset to 0 and the next SOB *SOB2* is reproduced. However, there are no

regulations for an interval of time between the reproduction of the *SOB1* and the reproduction of *SOB2*.

More specifically, as shown in FIG. 3, to reproduce the previous SOB *SOB1*, the count value is initialized to the ATS value of the first incoming packet data of the previous SOB *SOB1*, the ATS values of next packet data are compared with the count value, and only the packet data whose ATSs are equivalent to the count value is output. Likewise, after the reproduction of the previous SOB *SOB1*, the count value is initialized to the ATS value of the first incoming packet data of the next SOB *SOB2* and the next SOB *SOB2* is reproduced. However, there are no regulations on actions between the reproduction of the previous SOB *SOB1* and the reproduction of the next SOB *SOB2*, and thus, a pause is unavoidable during the reproduction. In conclusion, as apparent from FIG. 3, for continuous reproduction of the two SOBs *SOB1* and *SOB2* to which ATSs are individually allocated, the ATS processor initializes a value of the counter to the ATS value of the first incoming packet data of the next SOB *SOB2* and starts reproduction of the next SOB *SOB2* a predetermined time after the reproduction of the previous SOB *SOB1*. As a result, seamless reproduction of the two SOBs cannot be guaranteed.

SUMMARY OF THE INVENTION

The present invention also provides a method of guaranteeing seamless reproduction of a plurality of data strings consisting of packet data, and an apparatus for performing the same.

According to an aspect of the present invention, there is provided a method of guaranteeing seamless reproduction of a plurality of data strings, the method comprising creating continuous time control information that controls an instant of time when the data strings are output for the seamless reproduction of the plurality of data strings that include packetized data to which arrival time stamps are allocated.

According to another aspect of the present invention, there is provided an apparatus for reproducing a plurality of data strings, each of data strings consisting of packetized data to which ATSs are allocated, the apparatus comprising a reproduction controller that reads out a data string of the plurality of data strings from a recording medium; a counter that is driven in response to a system clock signal and reset with ATS that is allocated to first packet data read by the reproduction controller; a controller that changes the original ATSs of packetized data of a next

data string based on an ATS of first packetized data of the data string read by the reproduction controller and provides the changed ATSs, or generates a control signal indicating an instant of time when the counter must be reset; and an ATS processor that removes the ATSs from the data string read by the reproduction controller based on the changed ATSs and outputs the result when reproducing the data strings without resetting the counter; and resets the counter based on the ATS of the first packet data of the data string read by the reproduction controller in response to the control signal, removes the ATSs of the packet data of the data string read by the reproduction controller, and outputs the result when reproducing data strings after resetting the counter.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other aspects and advantages of the present invention will become more apparent by describing in detail preferred embodiments thereof with reference to the attached drawings in which:

FIG. 1 illustrates a basic format of packet data recorded to include arrival time stamps (ATSs), and the relationship between the arrival time of the packet data and data output time when the packet data is reproduced;

FIG. 2 is a block diagram illustrating the structure of an apparatus that records and reproduces the packet data shown in FIG. 1;

FIG. 3 illustrates a process of reproducing two stream objects (SOBs) using the apparatus of FIG. 2;

FIG. 4 illustrates a process of precisely calculating reference time with respect to an SOB encoded according to the MPEG-TS, MPEG-1, or MPEG-2 standards;

FIG. 5 illustrates a method of calculating a gap length value or an offset value required to set a counter, using the reference time calculated in FIG. 4;

FIG. 6 is a timing chart illustrating a method of calculating the reference time calculated in FIG. 4 using equations; and

FIG. 7 is a block diagram of a reproducing apparatus according to a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Hereinafter, preferred embodiments of the present invention will be described with reference to the accompanying drawings.

Main constituents of a reproducing apparatus according to the present invention are as follows:

1) counter that operates in response to system clocks;

2) reproduction controller that reads data strings from a recording medium;

3) controller that determines a value of an arrival time stamp (ATS) of first incoming packet data of a next data strings or controls time for resetting the counter, for seamless reproduction of different data strings; and

4) ATS processor that resets the counter or outputs data, based on ATS contained in data to be reproduced.

FIG. 4 illustrates a process of precisely calculating reference time with respect to SOBs *SOB1* and *SOB2* encoded according to the MPEG-TS, MPEG-1, or MPEG-2 standards. In FIG. 4, (a) shows the formats of programs recorded on a recording/reproducing apparatus in packet units, using ATSs. The programs are recorded according to the MPEG-TS standard, and thus, packets contained in the programs have program clock reference (PCR) values and presentation time stamps (PTSs). A PCR value is a counter value determined at an instant of time when the packet data is input to a buffer, which has a decoder, at a receiving side. In general, a PCR is conceptually identical to an ATS. However, a PCR value is contained in packet data but every packet does not contain a PCR value, whereas an ATS is allocated to packet data from the outside and every packet data has its own ATS.

In FIG. 4, (b) and (c) show ATS values and PCR values. If a clock, which is used to make an ATS value, is in synchronization with data encoded according to the MPEG-TS standard, respective ATSs correspond to respective PCRs in the SOB *SOB 1* at predetermined intervals δ of time.

In FIG. 4, (d) shows PTS values of data encoded according to the MPEG-TS standard. For instance, a PTS value may specify an instant of time when a sheet of image must be reproduced. In general, a sheet of image consists of a plurality of packet data and a PTS is contained in packet data related to the start of the image. In general, a PTS value of packet data is determined to be a larger number than a PCR value of the packet data.

Prior to seamless reproduction of two SOBs illustrated in FIG. 4, the seamless reproduction will now be defined. For reproduction of MPEG video data, a first image *P2* of the next SOB *SOB2* is required to follow a last image *P1* of the SOB

SOB1 without a pause. That is, the image *P2* must be reproduced right after the reproduced image *P1*. In FIG. 4, ① shows that a new PTS value of the image *P2* is computed by combining a PTS value of the image *P1* with a frame duration of the image *P1*. Here, the PTS value of the image *P1* is 3995 and the frame duration of the image *P1* is 110. ② shows that the image P2 can be reproduced right after the reproduced image P1 by making a new PCR value of the image *P2* so that the image *P2* reach a buffer at a receiving side time Δ before the new PTS of the image *P2*, when a difference between a PTS value of the image *P2* and a PCR value of first packet data of the next SOB *SOB2* is Δ. Here, the PTS value of the image *P2* is 2105, the PCR value of the first packet data of the next SOB *SOB2* is 2000, and the time Δ is 105. ③ shows that the new PCR of the image *P2* is computed by subtracting the time Δ from the new PTS value of the image *P2*, that is, the new PCR is 4000.

④ shows that a new ATS value of the image *P2* is computed to be 1000 when the new PCR is 4000, because the difference between each of the PCR values and each of the ATS values is maintained to be δ in the SOB *SOB1*. The new ATS value is an ATS value of the first packet data of the next SOB *SOB2* output when the counting operation of a counter is maintained after the output of the last packet data of the SOB *SOB1*. Thus, the new ATS value is called reference time in this disclosure.

FIG. 5 illustrates a method of calculating a gap length value or an offset value which is necessary to set a counter, using the reference time calculated in FIG. 4. Referring to FIG. 5, a gap length value is a difference between reference time and an ATS value of last packet data of an SOB *SOB1*. The gap length value is used when resetting the counter. The counter is reset with the value of an ATS of first packet data of an SOB *SOB2* and reproduction of the SOB *SOB2* starts when time corresponding to the gap length value has passed as from an ATS of last packet data of a previous SOB *SOB1*. The offset value is a difference between the reference time and an ATS of first packet data of the SOB *SOB2* and used when the counter is not to be reset. That is, respective ATS values of the SOB *SOB2* are

combined with the offset value while a counting operation of the counter is maintained. In this way, it is possible to draw an effect of reproducing the two SOBs *SOB1* and *SOB2* in response to the same arrival time clock (ATC), thereby guaranteeing seamless reproduction of the two SOBs.

FIG. 6 is a timing chart illustrating a method of calculating the reference time calculated in FIG. 4 using equations. Referring to FIG. 6, an article "7.3.2. Decoding Process during Playback of PlayItems with connection_condition set to 3 or 4", published in "Blu-ray Disc part 3 Audio Visual Basic Specifications version 1.0", suggests calculating a system time clock (STC) of an SOB *SOB2*, as follows:

$$L\_STC2 = L\_STC1 - STSC\_delta \quad \ldots (1),$$

wherein *L_STC1* denotes a long STC obtained from an STC of an SOB *SOB1* and *L_STC2* denotes a long STC obtained from an STC of the SOB *SOB2*.

When a system clock is used when encoding packet data at a transmitting side, the encoded packet data at a receiving side must be decoded at the same system clock. The STC is a value obtained from the system clock. By using STC, in receipt of the packet data, the receiving side can set a system clock of a recording/reproducing apparatus at the receiving side based on a PCR value of an SOB, thereby making the system clocks used by the transmitting and receiving sides in phase. The PCR is a time value obtained from the STC. ATS values are obtained based on the ATC. As explained with reference to FIG. 4, the difference between each ATS and each PCR is δ. That is, the difference between the ATC and the STC is also δ. This difference is called ATC_STC_delta. Therefore, Equation (1) can be expressed as follows:

$$ATC2 + ATC\_STC\_delta2 = L\_ATC1 + ATC\_STC\_delta1 - STC\_delta \quad \ldots (2),$$

wherein *L_ATC1* denotes a long ATC obtained from the ATC of the SOB *SOB1*.

By using Equation (2), a reference time value T2 *T2_L_ATC1* corresponding to an ATS of first packet data of the SOB *SOB2* can be calculated from the ATC *L_ATC1* of the SOB *SOB1*, as follows:

$$T2\_ATC2 + ATC\_STC\_delta2 = T2\_L\_ATC1 + ATC\_STC\_delta1 - STC\_delta$$
$$T2\_L\_ATC1 = T2\_ATC2 + ATC\_STC\_delta2 + STC\_delta - ATC\_STC\_delta1$$

... (3)

According to the present invention, reference time is calculated using Equation (3) and a counter resets ATS values of the SOB *SOB2* with a gap length value or an offset value calculated based on the calculated reference time. Therefore, a plurality of SOBs can be reproduced continuously without pause.

FIG. 7 is a block diagram of a reproducing apparatus according to a preferred embodiment of the present invention. Referring to FIG. 7, the reproducing apparatus includes a counter that operates in response to a system clock signal, a reproduction controller that reads stream objects from a recording medium, a controller that determines an ATS value of first packet data of a next SOB or controls an instant of time when resetting the counter, and an ATS processor, thus enabling seamless reproduction of consecutive SOBs read from the reproduction controller.

The reproduction controller sequentially reads out SOBs from the recording medium during data reproduction. Next, first packet data is reproduced while an initial count value of the counter is set to an ATS of the first packet data. Next, ATSs of incoming packet data are compared with the count value of the counter and only the packet data whose ATSs are equivalent to the count value are output. After completion of one SOB, the controller calculates an instant of time when first packet data is to be output or the counter is to be reset, using the Equations of FIG. 6, and then informs the ATS processor and the counter of the instant of time. Whether the controller will reset the count value of the counter to a specific time value or maintain the set count value, depends on whether the reproducing apparatus uses a gap length value or an offset value for seamless reproduction of the SOBs.

In the case of the reproducing apparatus using the gap length value, a time gap between reproduction of a previous SOB and reproduction of a next SOB is determined to be a gap length value so that the counter can be reset precisely at a desired instant of time, thereby guaranteeing seamless reproduction of the SOBs having different ATCs.

In the case of the reproducing apparatus using the offset value, the offset value is combined with or subtracted from respective ATSs of a next SOB to match a long ATC *L_ATC*, which is an expansion of the ATC of the previous SOB. In this way, it is possible to obtain an effect of reproducing SOBs having different ATCs in response to the same ATC, thereby enabling seamless reproduction of the SOBs.

As described above, according to the present invention, stream objects (SOBs) having different ATCs can be continuously reproduced without pause, using reference time.

What is claimed is:

1. A method of guaranteeing seamless reproduction of a plurality of data strings, the method comprising creating continuous time control information that is used to control an instant of time when the data strings are output for the seamless reproduction of the plurality of data strings that include packetized data to which arrival time stamps are allocated.

2. The method of claim 1, wherein the continuous time control information contains reference time and/or gap length information and/or offset information.

3. The method of claim 2, wherein the reference time is obtained by converting an output time value of first packet data of a next data string of the plurality of data strings into a value of an arrival time stamp (ATS) of last packet data of a previous data string.

4. The method of claim 2, wherein the offset information is a time value that is combined with or subtracted from ATSs of packet data of a next data string of the plurality of data strings, so that the ATSs can be converted into ATSs of a previous data string, the offset information being the difference value between the reference time value measured in claim 3 and the original ATS of first packet data of the next data string.

5. The method of claim 2, wherein the gap length information is a value indicating a time gap between output of first packet data of a next data string of the plurality of data strings and output of last packet data of a previous data string, the gap length information being the difference value between the reference time value and an arrival time value of the last packet data of the previous data string.

6. An apparatus for reproducing a plurality of data strings, each of data strings consisting of packetized data to which ATSs are allocated, the apparatus comprising:

a reproduction controller that reads out a data string of the plurality of data strings from a recording medium;

a counter that is driven in response to a system clock signal and reset with

ATS that is allocated to first packet data read by the reproduction controller;

a controller that changes the original ATSs of packetized data of a next data string based on an ATS of first packetized data of the data string read by the reproduction controller and provides the changed ATSs, or generates a control signal indicating an instant of time when the counter must be reset; and

an ATS processor that removes the ATSs from the data string read by the reproduction controller based on the changed ATSs and outputs the result when reproducing the data strings without resetting the counter; and resets the counter based on the ATS of the first packet data of the data string read by the reproduction controller in response to the control signal, removes the ATSs of the packet data of the data string read by the reproduction controller, and outputs the result when reproducing data strings after resetting the counter.

7. The apparatus of claim 6, wherein the continuous time control information contains reference time and/or offset information and/or gap length information.

8. The apparatus of claim 7, wherein when continuously reproducing the plurality of data strings without pause, the controller changes the original ATS of first packet data of a next data string into the reference time, changes an ATS of next packet data by combining the offset information with or subtracting the offset information from the ATS of next packet data, and provides the changes ATS of next packet data.

9. The apparatus of claim 7, wherein when continuously reproducing the plurality of data strings without pause, the controller combines the gap length information with an ATS of last packet data of a previous data string and generates a control signal indicating an instant of time when the counter is to be reset.

FIG. 1

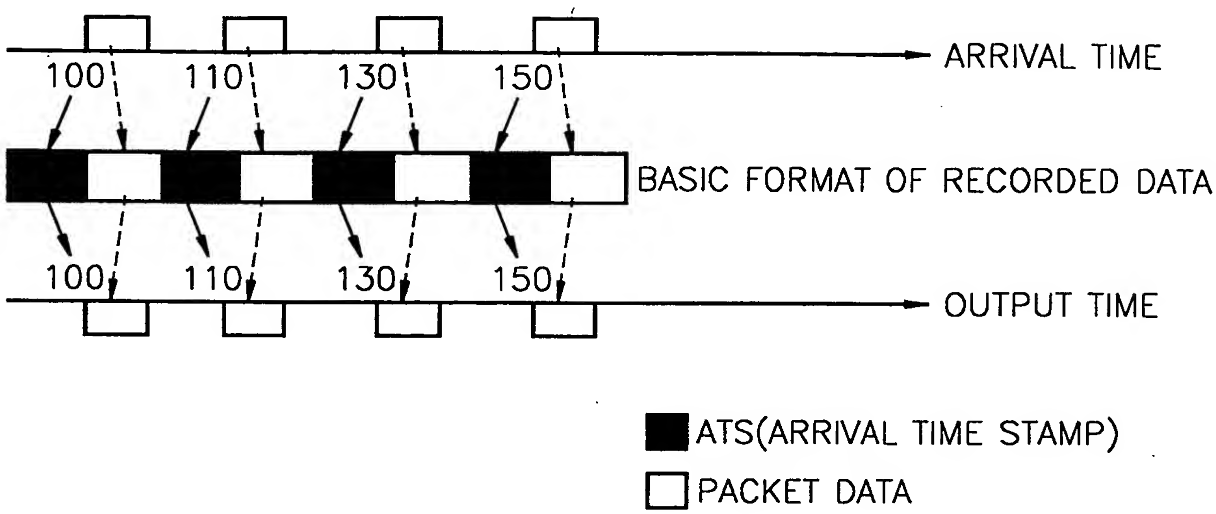

ARRIVAL TIME
100
110
130
150
BASIC FORMAT OF RECORDED DATA
100
110
130
150
OUTPUT TIME
ATS(ARRIVAL TIME STAMP)
PACKET DATA

FIG. 2

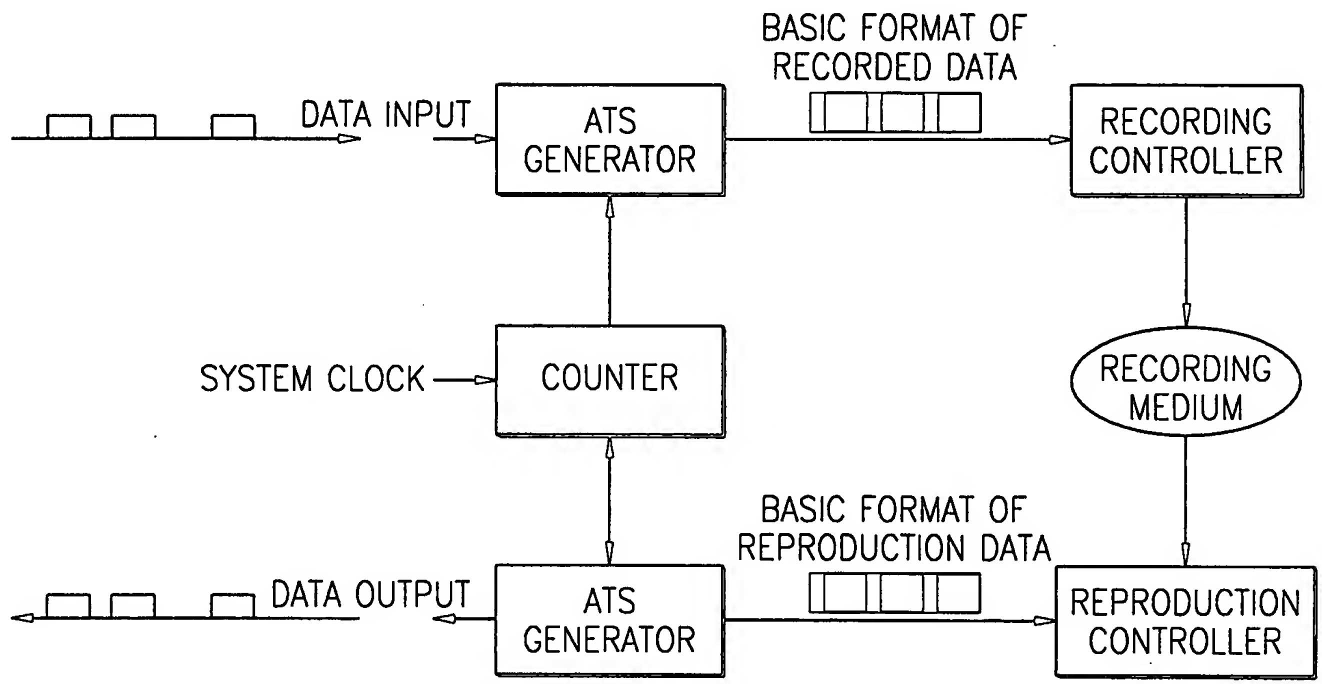
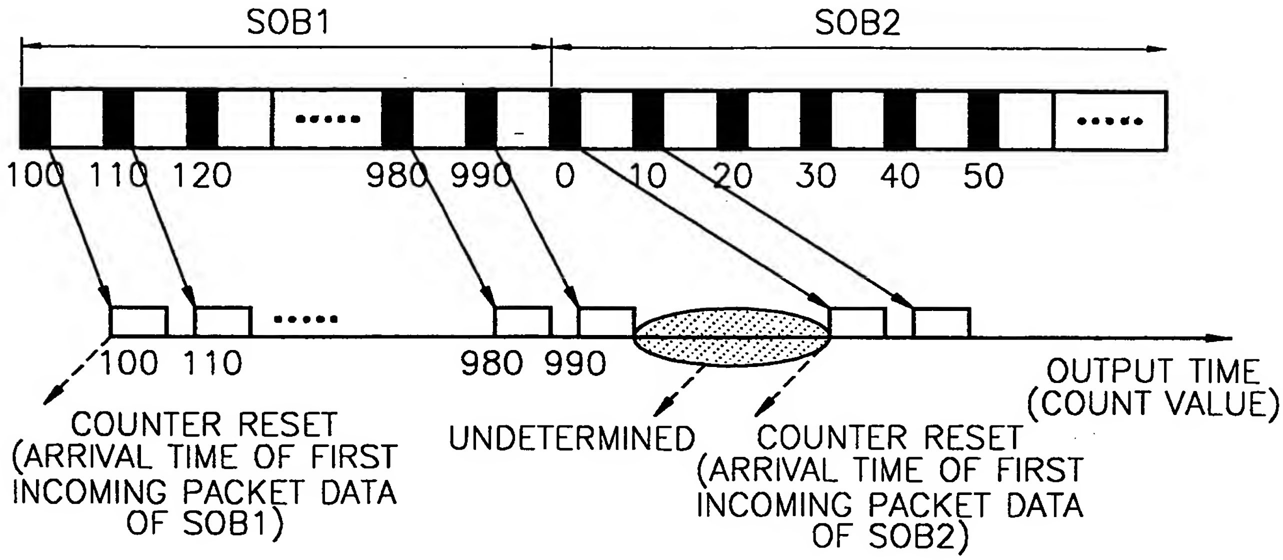

DATA INPUT
ATS GENERATOR
BASIC FORMAT OF RECORDED DATA
RECORDING CONTROLLER
SYSTEM CLOCK
COUNTER
RECORDING MEDIUM
BASIC FORMAT OF REPRODUCTION DATA
DATA OUTPUT
ATS GENERATOR
REPRODUCTION CONTROLLER

FIG. 3



SOB1
SOB2
100
110
120
980
990
0
10
20
30
40
50
100
110
980
990
OUTPUT TIME (COUNT VALUE)
COUNTER RESET (ARRIVAL TIME OF FIRST INCOMING PACKET DATA OF SOB1)
UNDETERMINED
COUNTER RESET (ARRIVAL TIME OF FIRST INCOMING PACKET DATA OF SOB2)

FIG. 4A

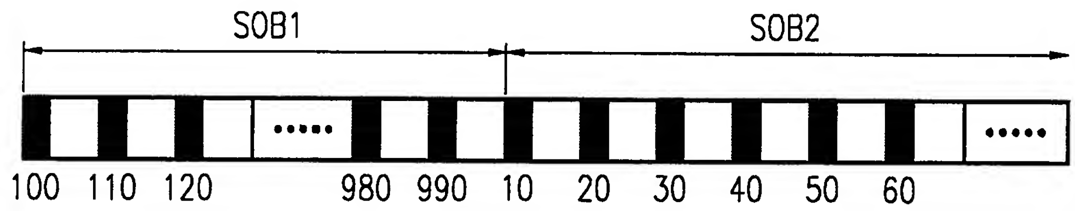


FIG. 4B

FIG. 4C

FIG. 4D

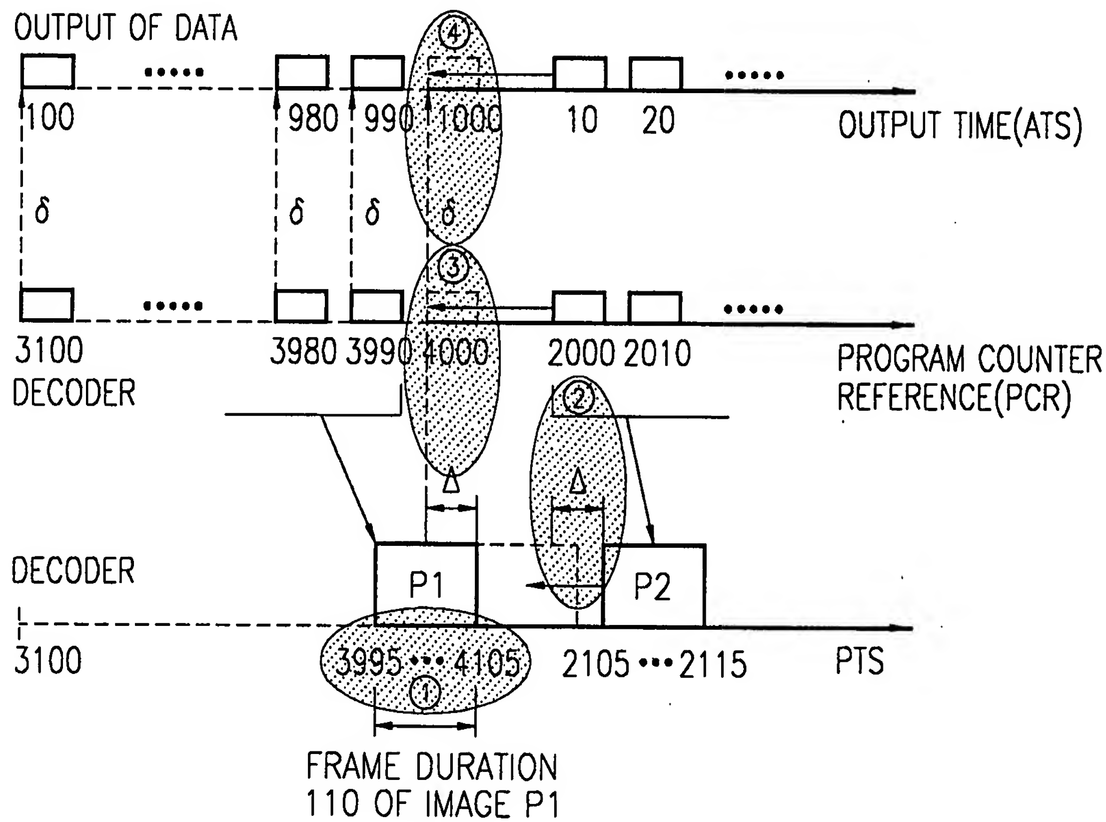
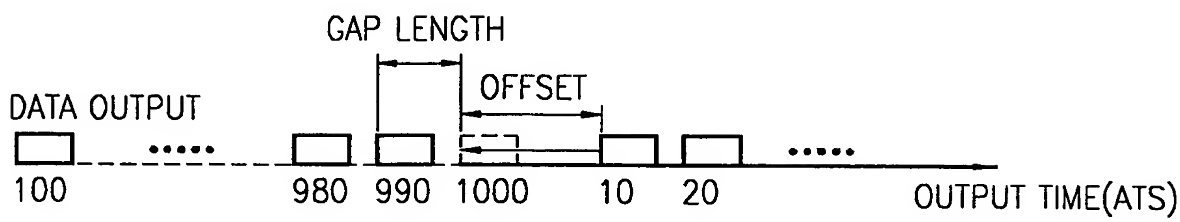


FIG. 5



GAP LENGTH
OFFSET
DATA OUTPUT
100
980
990
1000
10
20
OUTPUT TIME(ATS)

FIG. 6

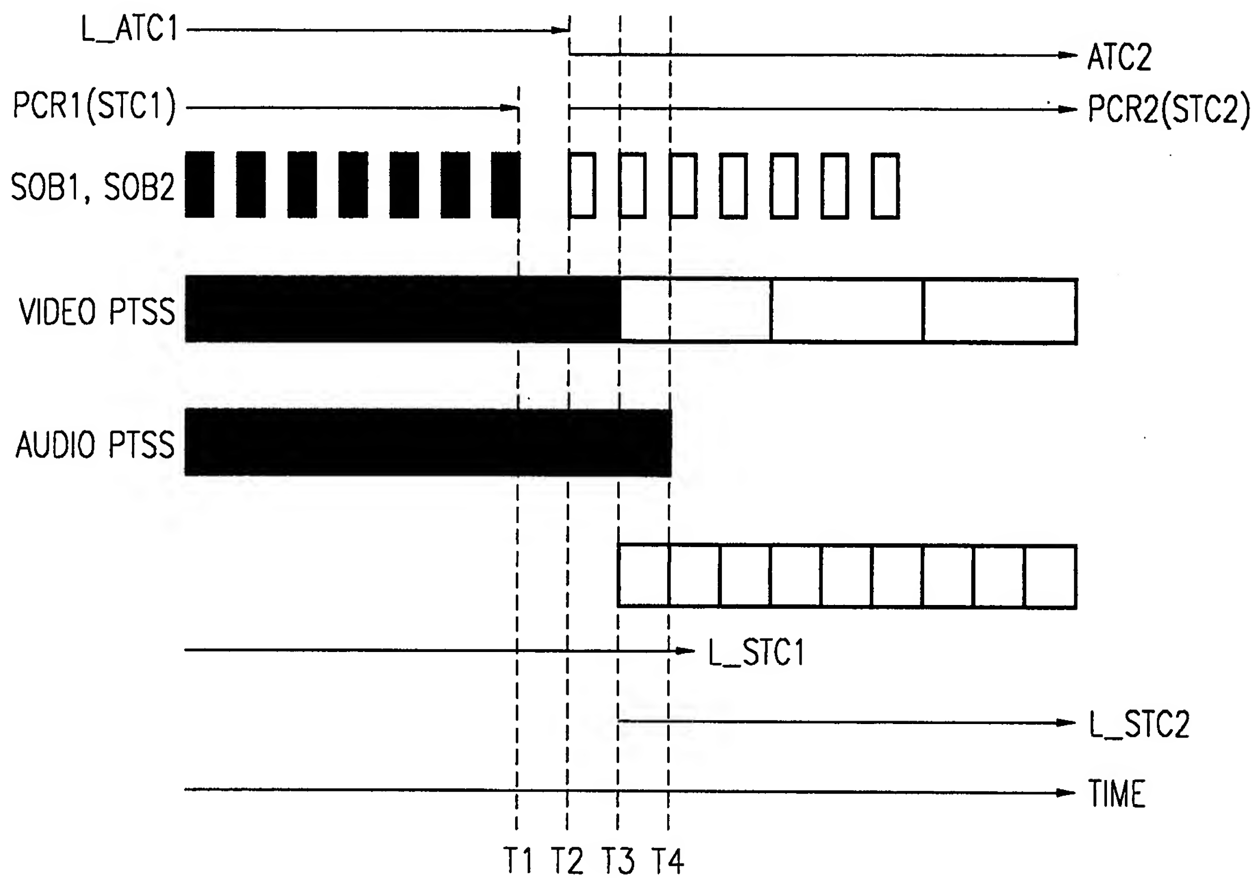
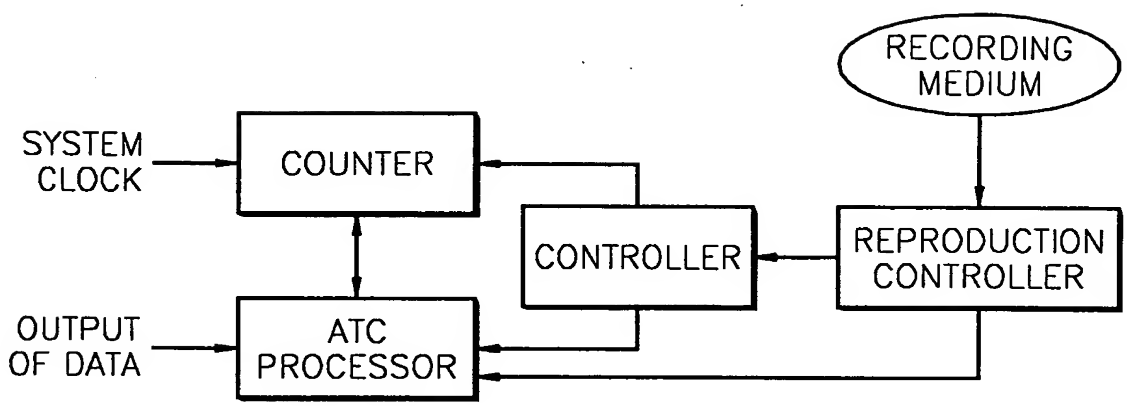

L_ATC1
ATC2
PCR1(STC1)
PCR2(STC2)
SOB1, SOB2
VIDEO PTSS
AUDIO PTSS
L_STC1
L_STC2
TIME
T1 T2 T3 T4

FIG. 7



RECORDING MEDIUM
SYSTEM CLOCK
COUNTER
CONTROLLER
REPRODUCTION CONTROLLER
OUTPUT OF DATA
ATC PROCESSOR